Evaluating the effectiveness of clinical medical librarian programs: a systematic review of the literature*

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Objective: This study was undertaken to determine if a systematic review of the evidence from thirty years of literature evaluating clinical medical librarian (CML) programs could help clarify the effectiveness of this outreach service model.

Methods: A descriptive review of the CML literature describes the general characteristics of these services as they have been implemented, primarily in teaching-hospital settings. Comprehensive searches for CML studies using quantitative or qualitative evaluation methods were conducted in the medical, allied health, librarianship, and social sciences literature.

Findings: Thirty-five studies published between 1974 and 2001 met the review criteria. Most (30) evaluated single, active programs and used descriptive research methods (e.g., use statistics or surveys/questionnaires). A weighted average of 89% of users in twelve studies found CML services useful and of high quality, and 65% of users in another overlapping, but not identical, twelve studies said these services contributed to improved patient care.

Conclusions: The total amount of research evidence for CML program effectiveness is not great and most of it is descriptive rather than comparative or analytically qualitative. Standards are needed to consistently evaluate CML or informationist programs in the future. A carefully structured multiprogram study including three to five of the best current programs is needed to define the true value of these services.

INTRODUCTION

Clinical medical librarian (CML) services have been implemented in dozens of different clinical health care settings since the first program started with grant funding from the National Library of Medicine in 1971 at the University of Missouri−Kansas City School of Medicine [1, 2]. Descriptions and evaluative discussions of these programs have been published with considerable regularity in the library and health sciences literature over the past three decades. However, a 1985 review by Cimpl (the former name of the first author of this review) of the first fifteen years of this literature found only eight published studies that used a survey or questionnaire to assess the value or cost-effectiveness of those early programs, and these studies pro-

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vided very limited data to support their generally positive assessments [3]. Since then, many more descriptive papers have been written as well as a number of additional studies incorporating at least some evaluative methodology. As a result, clinical librarianship has become a widely recognized, but still relatively infrequently used, model for extending library and information services into the clinical health care environment.

The current study was undertaken to determine if a systematic review of the cumulative, thirty years of evidence from the literature evaluating CML programs could help provide a more definitive determination of the potential effectiveness of this model of outreach service and also help inform the current debate on the potential for developing CML-like ''informationist'' roles in health care settings [4, 5]. However, we were not optimistic and hypothesized that the published literature would provide little additional strong evidence showing how or if CML services contribute to improved patient care or better performance of health professionals in clinical health care settings.

The paper that follows first provides a descriptive review of the entire CML literature to show the general characteristics of these services as they have been implemented, primarily in teaching-hospital settings. This review also includes other related research studies in clinical health care settings about the impact of information services on education and patient care as well as more recent articles suggesting that health sciences librarians can play a significant role in evidence-based medicine and knowledge management. The next section of the paper describes the criteria and methods used to screen the CML literature for evaluative studies along with the characteristics and measures used to categorize and analyze the thirty-five evaluative studies of CML programs identified from this systematic review. Summary tables are then presented and discussed. The paper concludes with a consideration of the implications of this review for the development of future clinical librarian or informationist services and some recommendations for future evaluation research studies.

BACKGROUND AND SIGNIFICANCE OF CLINCIAL MEDICAL LIBRARIAN (CML) SERVICES

Clinical medical librarian services (sometimes called just ''clinical librarian'' services) were originally conceived by librarians as a way to integrate health sciences library services and the literature searching expertise of medical librarians into the patient care setting [6]. A primary goal of almost all these programs has been to overcome the time, cost, and expertise barriers that clinicians face when they attempt to incorporate the best current evidence from the literature into their patient care decisions. An important secondary goal of most of these programs has been to enhance the educational experience of students and resident physicians in training [7, 8]. Much like clinical pharmacists, social workers, nutritionists or other allied health professionals, clinical librarians have typically worked as visiting adjunct members of the patient care team for part of their work day or work week in settings such as teaching or inpatient rounds, morning report, and other clinical conferences or journal clubs. The remainder of their time is usually spent in the health sciences library searching, summarizing, and packaging information for delivery back to individuals or to the entire health care team [9–17].

By moving the librarian away from the traditional, in-library reference desk into a clinical setting, CML services have been promoted as a way for the librarian to develop a better understanding of the specific patient-care context of information needs [18, 19]. In addition, by providing an opportunity for the CML to learn about and directly experience the work environment of clinicians, the experience has enabled many CLMs to anticipate information needs and regularly deliver relevant documents or literature search results before they are actually requested [20–25]. CML services began in an era (the early 1970s) when bibliographic database searching was almost exclusively the professional domain of specially trained librarians. Since then, the introduction of very user-friendly search engines and freely accessible versions of MEDLINE and other databases on the Web has shifted the emphasis of many CML services from facilitating and mediating access to information to educating health care team members about the strategies needed to effectively use these resources on their own [26–30].

Most CML programs have been limited to one, or a few, clinical services in institutions where the department head or other clinical team leaders have been supportive and willing to underwrite the extra costs of the CML services or where the clinical service is willing to serve as a project test bed for this new service piloted with library funds [31–35]. CML roles, as described in the numerous published case reports, have included providing research assistance for clinical faculty [36–38], providing bibliographies on requested topics [39–42], selecting and summarizing or abstracting articles to elucidate problems in patient care [43–45], educating students and clinical team members about effective information searching and resource management [46–50], providing information to patients and their families [51–53], and serving as ambassadors to promote the use of traditional library services [54, 55]. These reports have also discussed the various factors presumed to contribute to CML program success or failure, including the degree to which the librarian is accepted as a member of the health care team, the medical knowledgebase of the librarian, the librarian's willingness to undertake the CML role, the frequency with which the CML services are requested and used by members of the health care team, and the cost of the services and the budget resources available to support those costs [56–65].

RELATED RESEARCH

Over the past fifteen years, the development of additional CML programs has also been supported and

stimulated by a number of related studies that have attempted to assess the general impact of hospital library services on the quality and costs of clinical care [66]. Three of these studies have been particularly influential. The first, conducted by King in 1986, studied the contribution of hospital library information services to clinical decision making and patient care [67]. Using an unobtrusive design, the study asked 310 physicians and other health professionals to request information on a current case or clinical situation from the hospital library and then to complete a questionnaire on the results without revealing their involvement in the study to library staff. Of the 176 valid responses received, 74% reported that they probably or definitely would have handled the case differently with the information received from the library. In 1990–1991, using a similar methodology, Marshall coordinated a study surveying 448 physicians in fifteen hospitals [68]. Of the 208 questionnaires returned, 80% reported that they either probably or definitely would have handled some aspect of patient care differently. A third major study, conducted in three major teaching hospitals by Klein and colleagues in 1989–1990, investigated the relationship between hospital costs, charges, and length of stay for 192 test patient cases for which MEDLINE searches were conducted and over 10,000 control cases for which MEDLINE searches were not conducted [69]. They found that when a MEDLINE search was conducted during the first half of the hospital stay, the test-case patients had statistically significant lower hospital costs, charges, and lengths of stay.

Another much more recent area of concern about the use of the clinical health sciences literature is the need for ''conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients'' [70]. This growing evidence-based medicine (EBM) movement (which also extends to nursing, dentistry, public health, and other health professions) now includes international efforts (such as the Cochrane Collaboration [71]) to produce rigorous, systematic reviews of the literature and specialized databases to guide clinical practice [72]. Evidence-based medicine is also providing additional opportunities for health sciences librarians, including clinical librarians, to demonstrate their literature searching expertise with clinicians who need to search, evaluate, and access the best current evidence [73–75]. This collaborative EBM work has even suggested the need for ''evidence-based librarianship'' to improve the professional services of librarians working with clinicians and researchers [76].

Finally, CML and EBM strategies have both suggested the possibility of developing greatly expanded ''knowledge management'' roles for information professionals in clinical settings. These roles would require the integration of ''individual clinical expertise with the best external evidence'' [77, 78]. Davidoff and Florance have called for the creation of a clinical ''informationist'' professional role within clinical health care teams to provide this knowledge management expertise [79]. This suggestion has provoked widespread discussion and debate [80, 81] as well as suggestions for how to train health professionals or librarians to assume these expanded roles [82–84].

SYSTEMATIC REVIEW METHODS USED

The systematic review phase of this study started with comprehensive searches in medical, allied health, librarianship, and social sciences literature databases (MEDLINE, Library Literature, Library and Information Science Abstracts, and Social Sciences Citation Index) to locate published studies dealing with any aspect of clinical medical librarianship. The search terms used included ''clinical,'' ''medical,'' ''library,'' ''librarian,'' ''librarianship,'' ''CL,'' and ''CML.'' The Institute for Scientific Information's SCISEARCH database was also used to scan all articles citing Cimpl's 1985 review. The references in the resulting articles were also scanned for additional studies and reports. Finally, this process identified two British colleagues (Winning and Beverly) who were also engaged in a similar effort to review ''primary [clinical librarianship] studies which included an evaluative research element,'' but limited to studies published after 1982 (because they aimed to ''build upon'' and not replicate the 1985 Cimpl review) [85, 86]. They were generous in sharing their literature search results prior to the publication of their review, thus providing additional citations for consideration in this review. This process yielded over 250 citations to reports and studies published between 1974 and 2002 that dealt directly or indirectly with some aspect of clinical librarianship.

Based on the titles, source journals, or abstracts of the papers, we next identified and then located full-text copies of 107 potentially relevant studies for closer examination. Each paper was read to determine if any more-or-less-formal quantitative or qualitative methods were used by the authors to evaluate some aspect of a single (or more than one) clinical librarianship service or program. Following the model for medical informatics evaluative studies outlined by Friedman, Owens, and Wyatt [87], each article was further evaluated for any formal methods used to study either the need for CML services, the development process for those services, the effectiveness of the structure or functions of the program, or the outcome effects of the CML services on patient care, education, or research in the clinical setting. Evidence of more formal evaluative research methods included one or more of the following: a careful description of the population or sample of clinicians receiving CML services and the setting(s) in which the services were provided; questions or hypotheses posed about the need, reliability, effectiveness, or impact of the services in the introduction sections of the article; tables or graphs summarizing data collected from the program; and a ''methods'' or ''results'' section in the structure of the paper.

This review determined the final group of thirty-five papers reporting studies with some evidence of formal quantitative or qualitative evaluation methods. These

Table 1
Bibliographic information for all identified evaluative studies of clinical medical librarian (CML) programs; arranged chronologically from 1974 to 2001

1. Algermissen V. Biomedical librarians in a patient care setting at the University of Missouri–Kansas City School of Medicine. Bull Med Libr Assoc 1974; 62(4): 354–8.
2. Roach AA, Addington WW. The effects of an information specialist on patient care and medical education. J Med Educ 1975;50(2):176–80.
3. Lamb G. And now ''clinical librarians'' on rounds. Hartford Hosp Bull 1975;30(2):77–86.
4. Staudt C, Halbrook B, Brodman E. A clinical librarians' program: an attempt at evaluation. Bull Med Libr Assoc 1976;64(2):236–8.
5. Schnall JG, Wilson JW. Evaluation of a clinical medical librarianship program at a university health sciences library. Bull Med Libr Assoc 1976;64(3): 278–83.
6. Greenberg B, Battison S, Kolisch M, Leredu M. Evaluation of a clinical medical librarian program at the Yale Medical Library. Bull Med Libr Assoc 1978; 66(3):319–26.
7. Marshall JG, Hamilton JD. The clinical librarian and the patient: report of a project at McMaster University Medical Centre. Bull Med Libr Assoc 1978; 66(4):420–5.
8. Byrd GD, Arnold L. Medical school graduates' retrospective evaluation of a clinical medical librarian program. Bull Med Libr Assoc 1979;67(3):308–12.
9. Gunning JE, Fierberg J, Goodchild E, Marshall JR. Use of an information retrieval service in an obstretrics/gynecology residency program. J Med Educ 1980;55(2):120–3.
10. Scura G, Davidoff F. Case-related use of the medical literature: clinical librarian services for improving patient care. JAMA 1981 Jan;245(2):50–2.
11. Marshall JG, Neufeld VR. A randomized trial of librarian educational participation in clinical settings. J Med Educ 1981;56(5):409–16.
12. Grose NP, Hannigan GG. A clinical librarian program in a family medicine residency. J Fam Pract 1982;15(5):994,998.
13. Kidder AJ. Clinical librarian program [Letter]. J Med Educ 1982;57(6):503.
14. Harmony SE. Evaluating a clinical librarian program: a necessary evil or valuable tool? Clin Libr Q 1983;1(4):1–5.
15. Tobia RC, Kronick DA, Harris GD. A clinical information consultation service at a teaching hospital. Bull Med Libr Assoc 1983;71(3):396–9.
16. Glick J, Sullivan M. CML in a satellite library. Clin Librn Q 1984;3(1/2):5–9.
17. Cimpl K. Clinical medical librarianship: a review of the literature. Bull Med Libr Assoc 1985;73(1):21–8.
18. Yates-Imah C, Goldschmidt RH, Johnson MA. The clinical librarian: new team member for a family practice inpatient service. Fam Med 1985;17(6):262–4.
19. Eaton EK. Evaluation and model of a clinical librarian program [Dissertation]. Galveston: University of Texas Graduate School of Biomedical Sciences, 1985.
20. Miller N, Kaye D. The experience of a department of medicine with a clinical medical library service. J Med Educ 1985;60(5):367–73.
21. Barbour GL, Young MN. Morning report: role of the clinical librarian. JAMA 1986;255(14):1921–2.
22. Demas JM, Ludwig LT. Clinical medical librarian: the last unicorn? Bull Med Libr Assoc 1991;79(1):17–27.
23. Veenstra RJ. Clinical medical librarian impact on patient care: a one-year analysis. Bull Med Libr Assoc 1992;80(1):19–22.
24. Veenstra RJ, Gluck EH. A clinical librarian program in the intensive care unit. Crit Care Med 1992;20(7):1038–42.
25. Kuller AB, Wessel CB, Ginn DS, Martin TP. Quality filtering of the clinical literature by librarians and physicians. Bull Med Libr Assoc 1993;81(1):38–43.
26. Royal M, Grizzle WE, Algermissen V, Mowry RW. The success of a clinical librarian program in an academic autopsy pathology service. Am J Clin Pathol 1993;99(5):576–81.
27. Pasquinelli LM, Buescher ES, Gowen CW Jr. Report of a survey: impact of a clinical medical librarian on resident education. J Investigative Med 1994:2A.
28. Giuse NB, Kafantaris SR, Miller MD, Wilder KS, Martin SL, Sathe NA, Campbell JD. Clinical medical librarianship: the Vanderbilt experience. Bull Med Libr Assoc 1998;86(3):412–6.
29. Iruoje MA, Henner JK, Akinade OJ. The role of the clinical librarian in patient management. Nigerian Q J Hosp Med 1999;16:216–7.
30. Dodson S. A clinical medical librarian program into the next millennium [Web document]. Seattle: University of Washington Health Sciences Library, 1997. [cited 12 Aug 2003]. ⟨http://healthlinks.washington.edu/hsl/liaisons/dodson/cml.html⟩.
31. Morley SK, Buchanan HS. Clinical medical librarians: extending library resources to the clinical setting. J Hosp Libr 2001;1(2):15–30.
32. Reid L, Ikkos G, Hopkins W. The impact of clinical governance on the library and information service: clinical librarian case study. IFMH Inform Newsletter IFM Health Care 2001;12(1):1–3.
33. Glassington L. The library and information support for clinical effectiveness (LISCE) project—eight months on. [Web document]. London, U.K.: University College London, Knowledge Management Centre, 2001 [cited 12 Aug 2003]. <http://www.ucl.ac.uk/kmc/kmc2/News/ACKM/ackm4/glassingotn.html>.
34. Ward LM, Honeybourne CJ, Harrison J. A clinical librarian can support clinical governance. Brit J Clin Governance 2001;6(4):248–51.
35. Honeybourne C. Clinical librarian service: providing research evidence at the point of clinical need [Web document]. Leicester, U.K.: University Hospitals of Leicester NHS Trust, Education Centre Library, 2001. [rev. 11 Feb 2001; cited 12 Aug 2003]. <http://www.le.ac.uk/li/lgh/library/clpplan.htm>.

were then read more carefully and categorized in spreadsheet tables according to the hypotheses or problems they proposed to study, the research methods they used (including the data or other measures studied and how these were collected and analyzed), the study period and institutional setting, the population or sample of clinicians who received CML services, the quantitative or qualitative research results reported, and any implications for the future suggested by the authors. Quantitative research results, where available, were carefully recorded, along with their statistical parameters in case something approaching a meta-analysis statistical summary could be calculated from the combined results of the studies reviewed. Although meta-analysis has been used primarily for statistically combining the results of clinical trials, it has been suggested that such studies can help support ''evidence-based librarianship'' and can also be used by clinical librarians or informationists to bring summaries of the best evidence into the clinical setting [88, 89].

FINDINGS

Table 1 summarizes the bibliographic information for the thirty-five evaluative studies of CML services that met the criteria outlined above (one additional *unpublished* evaluation study in Australia was called to our attention by its first author [90]). Interestingly, the seventeen evaluative studies published after 1982 that were included in the Winning-Beverley systematic review [91] were also all selected according to the criteria used for this review. However, our review also includes three additional studies published after 1982 (Kuller, Morley, and Glassington) that Winning and Beverley determined to be simply descriptive. Finally, our review identified fifteen other earlier studies, including Cimpl's 1985 review, twelve of the studies cit-

Table 2
Distribution of CML evaluative study general characteristics

Studies
30 A single, active program
1 Retrospective opinions (Byrd)
0 Experience of ''new'' medical libraries (Kidder)
1 The published CML literature (Cimpl)
1 Clinicians' and librarians' opinions (Demas)
1 Program evaluation methods (Honeybourne)

Data studied
33 Actual program data
Secondary data from literature (Cimpl)
1 Simulated data in survey (Demas)

Data collection methods used
20 Use statistics
13 Questionnaires
10 Surveys
9 Interviews
5 Informal comments
3 Rating forms
4 Miscellaneous other methods

Research methods used
31 Descriptive
3 Nonrandom controls
2 Historical controls
1 Random control (Marshall/Neufeld)

Aspects of service studied
30 Effects on users
21 Program functions
12 Program development process
8 Program costs
2 Effects on the library
1 Program need (Demas)

Service impacts studied
31 Clinical, patient care
21 Educational
11 Library services
4 Research

ed in that review, and two additional studies that had been missed by Cimpl (Lamb and Marshall/Neufeld).

These thirty-five studies were published between 1974 and 2001 in fourteen different journals as well as in a dissertation and on three Websites. The *Bulletin of the Medical Library Association* accounts for 37% of the total (13), but the library literature as a whole accounts for less than half (15 or 43%). The rest are scattered among various general and clinical medical journals, with two journals each accounting for more than one study: the *Journal of Medical Education* (5) and *JAMA* (2). In all, seventy-seven different individuals contributed to these studies, but only four contributed to more than one (V. Algermissen, C. Honeybourne, J. G. Marshall, and R. J. Veenstra each authored or co-authored two studies). In the tables and discussion of the systematic review results presented in the rest of this paper, these studies will be identified by the last name of the first author and, where necessary, the first co-author.

Table 2 summarizes the general characteristics and research methods used in each of the thirty-five studies. With only five exceptions, these studies have focused on single active programs (although often serving several clinical patient care units or departments), usually in individual hospitals or other clinical settings. The results reported were most often based on actual data collected by practicing CMLs in those settings using descriptive data collection and analysis methods such as use statistics, surveys, questionnaires, or interviews. Also, the great majority of these studies focused on users' perceptions of the usefulness and effectiveness of CML services or the functional efficiency of the services as well as the patient-care or educational impact of the information provided.

Atypical studies

Table 3 briefly summarizes the period and setting, subject population and sample, objectives, and results of the five atypical CML-program evaluation studies. In general, these five studies reported very mixed results using a combination of current, retrospective, and needs assessment data. The results included a variety of opinions from users of CML services and other potential supporters about the benefits and problems associated with these services. The benefits reported included the helpfulness and personal attention to information services, including instruction provided by, or anticipated from, CMLs. The problems reported included the difficulty of finding the resources needed to hire and train librarians to provide these services for all clinical health care teams and the potential for inadequately trained librarians to misinterpret clinical information needs. These atypical evaluation strategies also demonstrated a variety of macro- and micro-approaches, ranging from a literature review and a retrospective survey of the former student users of one CML program to a national survey of librarians and clinical department heads and a project evaluation plan based on a ''scoping study.''

The Byrd and Honeybourne studies each focused on a single CML program. Byrd evaluated the retrospective opinions of practicing physicians who had used one school's CML services while they were undergraduate medical students, and Honeybourne described a proposal to develop a methodology for evaluating a CML program that had not yet been fully implemented. Kidder's letter to the editor described a 1980 survey of twenty-four ''new'' medical school libraries (located in schools that graduated their first class in or after 1972) asking about the status of any current or previous CML programs at their institutions. Cimpl used secondary data from a review of the CML literature published before 1985 to assess the costs of, and evaluation strategies used for, programs up to that date. Finally, Demas described a double-blind survey of a sample of 120 clinical department heads and 40 library directors in academic medical centers without CML programs, using scenarios describing CML services to assess acceptance of, and attitudes toward, the CML service model.

Single-program study characteristics

Table 4 summarizes the evaluation periods, strategies, and settings; number of CMLs, venues, and frequency of services; the study population and sample numbers and characteristics; the problems and hypotheses investigated; and the results reported from the remaining thirty evaluative studies focusing on single programs. The evaluation period for these studies ranged from six weeks to five years, with a median period of one year. The most common evaluation strategy has been the collection and analysis of usage statistics from the CML services provided (20 studies); followed by the use of surveys or questionnaires (13 studies), often distributed with the articles and other information given to health professional users by the CMLs (9 studies); one-time surveys conducted at the end of the defined evaluation period (10 studies); and interviews with users (9 studies). Many evaluators used more than one strategy in combination, but all of these and some other scattered methods (such as diaries or work logs, rating forms, and informal user feedback) are essentially descriptive.

Only four studies used, or suggested, more rigorous comparative research methods. Two used historically controlled before-and-after methods, with pre- and post surveys or interviews to measure the changes attributable to the CML services (Gunning and Eaton). One study used randomly selected intervention and control groups to experimentally test the extent to which the measured outcomes could be attributed to the CML services provided (Marshall/Neufeld), and one additional recent study described a plan to also use control teams to ''compare their information use with that of the study teams'' (Reid), but the study results reported did not include any data from that comparison.

The most common settings for these studies were hospital clinical departments, units, or teams; most frequently in departments of medicine or internal medicine (19); followed by departments of pediatrics (7); intensive care units (5); departments of surgery (4); and obstetrics and gynecology (3). Most of the CML programs in these studies served only one clinical department or unit (16 studies), but a number were serving two (4), three (4), or four units (5), and one evaluated program was serving ten different clinical units (Reid).

Most of these programs (20) used just one, usually part-time, CML to provide the evaluated services, but a few programs employed two (5), three (Algermissen, Lamb, and Eaton) or four (Greenberg and Giuse) CMLs. The evaluated services were usually provided while attending patient care rounds or conferences, such as morning report, and only ten of the evaluated CML programs provided these services on a daily schedule. The most frequent schedule of attendance at rounds or conferences was once a week (12 programs), with the rest scheduled two, three, or ''several'' times each week.

The number of health care professional users of CML services surveyed or otherwise studied in each of these programs ranged from 10 to about 270 people, with a median of 35 and an average of 64. The target population most frequently served by these programs was resident physicians in training, or ''house officers'' as they were sometimes labeled (22 programs). Other health professionals often targeted by these programs included faculty or staff physicians or ''clinicians'' (19 programs), nurses (9 programs), and undergraduate medical students (7 programs). A number of other allied health profession and student users were identified as part of the evaluation strategies of many programs, and two also targeted patients and their families (Marshall/Hamilton and Marshall/Neufeld).

The problems identified or goals outlined by the authors of these studies included a fairly wide range of questions or issues surrounding the effective provision of CML services. Most often these research problems or goals were not explicitly stated as such in the published article, but could be inferred from the introductory paragraphs. Only six studies also included specific research-hypothesis statements to be tested by the study methodologies and results. The most frequent category of problem identified in these studies related to how the CML services would affect patient care by the health professional users, or more specifically, the quality of their diagnoses and treatments (20 studies). The next most frequently noted problems investigated were the impact of CML services on the graduate education of residents (8 studies) and the efficiency and timeliness of the CML services provided (6 studies). Other problems investigated with some frequency included the degree to which the CML was accepted as a member of the clinical health care team, whether the CML services helped to stimulate increased use of traditional health sciences library services and resources, whether the CML-provided information resources improved the team members' knowledge of the clinical literature, and how the team viewed the overall quality and value of the CML program (each of these problems was investigated in four studies). A wide range of other more specific questions was also mentioned as problems or goals in these studies, ranging from how often team members would share CML-provided information with others to whether a library-based service could substitute for CML attendance at rounds or conferences.

Single-program study results

The results reported from these studies (which usually, but not always, correspond with the goals and hypotheses stated in the introductions to these articles) are shown in the last column of Table 4. These results statements have also been categorized and further summarized in Table 5. This analysis shows (in the second column) that twenty studies reported 41 specific ways in which CML services made an impact on the provision of patient care in these settings. Another, not entirely identical, nineteen studies included 29 reported results statements about the perceived usefulness, adequacy, or quality of the CML-provided infor-

Table 3
Five atypical CML program evaluation studies

Author (study no.)	Period and setting	Subject population and sample	Objectives	Results
Byrd (8)	■ Spring 1977 survey ■ University of Missouri–Kansas City School of Medicine	■ 1st 66 graduates of the School of Medicine ■ 47 usable responses	■ Present library use behaviors ■ Retrospective perceptions of UMKC CML services	■ Able to use other libraries effectively (83%) ■ Very positive recollections of CML services: –Current awareness services (92%) –Quality of instruction provided (81%) –"No problems" (77%) –Anticipating information needs (72%) –Personalized attention (66%) –Helpfulness –Time savings
Kidder (13)	■ ca. 1980 survey ■ Southern Illinois University School of Medicine Library	■ 24 "new" medical school libraries ■ 21 usable responses	■ Status of other CML programs ■ Compare to reason for discontinuing SIU Library's CML program after 5 years (was detrimental to general reference services provided to entire medical school)	■ Only 7 libraries had ever had a CML program ■ 2 programs limited to a single clinical department ■ 4 programs had been cut back: –2 because of lost grant funding –1 because department requested elimination –1 because of lack of staff ■ Budget and staff shortages biggest factor
Cimpl (17)	■ 1974–1984 ■ The published CML literature	■ 23 CML programs described in the literature ■ 8 CML program evaluation studies summarized (Staudt, Schnall, Greenberg, Marshall/Hamilton, Byrd, Gunning, Grose, & Harmony)	■ Review literature to analyze the history and evolution of CML programs ■ Study evaluation methods used ■ Study cost–effectiveness of CML programs	■ Reported benefits of CML programs: –Enhancement of patient care –Education of health care team –Better awareness of library services and resources –Time savings for health care team –Exposure to more journals –Information sharing among colleagues –More visibility for library –Librarians' improved knowledge of medical terminology and procedures ■ Reported problems of CML programs: –Adds to overcrowding on rounds –Sometimes misunderstand questions –Question having CML as the primary information resource for the health care team –Users who identify with CML as an individual rather than as part of library team –Traditional library services suffer ■ Cost considerations noted: –Clinical departments generally unwilling to share costs –Reported actual costs compare favorably with hospital X-ray and laboratory services
Demas (22)	■ 1990 survey ■ US medical schools where the library does not offer CML services	■ 120 clinical department chairs ■ 40 academic health science library directors ■ 79 usable responses from chairs: –28 from internal medicine departments –26 from pediatrics departments –25 from surgery departments ■ 30 usable responses from library directors	■ Receptiveness of medical school leaders to implementation of a CML program	■ Strong agreement on potential value of a CML program for health care team ■ Mild agreement on potential importance for patient care and medical education ■ Agreement that librarians should teach medical students to search the literature ■ Mild agreement that CMLs would have the expertise to choose relevant articles ■ Mild disagreement that most health care team members prefer doing own library research

Table 3
Continued

Author (study no.)	Period and setting	Subject population and sample	Objectives	Results
				■ Library directors strongly agree CML program costs should be shared: –Clinical dept. chairs mildly disagree
Honeybourne (35)	■ 2000 program plan –3-year funded project (August 2000 to June 2003) ■ University Hospitals of Leicester, National Health Service Trust, United Kingdom	■ Proposed: 16 clinical departments at 3 hospital sites, each served by one clinical librarian	■ Provide an evaluated model of best practice ■ Evaluation questionnaire with each completed CML search to measure: –Timeliness –Usefulness –Number of full–text articles obtained –Impact on patient care	N/A

mation resources. Smaller, but still significant, groups of studies reported statistics and trends about the use of the CML services (12), the impact of CML services on traditional health sciences library services (11), the overall value of the CML program (11), the educational impact of the CML services (10), the health care teams' acceptance of the CML as a colleague (7), and the extent to which CML services saved users' time (7). The remaining eight categories of results, including potentially negative impacts of these services, were each reported in six or fewer studies.

The remaining columns in Table 5 show (1) the total estimated number of users (or uses) of CML services represented in the combined results for each category across all the studies; (2) the combined total number of studies (and individual results statements) in each category that included a quantitative percentage of positive responses from the users studied; (3) the total estimated number of users (or uses) of CML services represented in those studies reporting numerical percentage positive results statements; (4) the positive percentage range reported in those results statements; and (5) a weighted average of all the percentage results reported in each category, using the number of users (or uses) with positive results in each study as the weighting factor. These statistics were derived and calculated from Table 4, which, in addition to the individual results statements listed in the last column, includes, in the fourth column, the number of individuals (or information resources uses) studied in each of these evaluation reports.

Although the numbers as presented here look precise, it is important to emphasize that in some cases the published articles provided only very general information about the numbers of individual CML-service users studied (estimates are indicated with question marks on Table 4). However, the figures in Table 5 do provide a fair estimate of the total relative numbers of health professionals (or their uses of CML services) included in these evaluation studies.

The combined total number of users studied, for each category of CML- service impact, ranged from 14 to about 1,200. Two studies also included evaluation data based on an evaluation form linked to the articles or other search results provided to users by CMLs (324 returned evaluations for the Staudt study, and 37 for the Tobia study). The percentages of positive impacts reported for individual result statements in all the studies ranged from 6% (for the proportion of CML service users in one study who felt that CML information contributed to avoiding hospital infections [Dodson]), to 100% for twelve different statements reporting study results in five of the categories on Table 5. The weighted averages of positive percentage results statements in each category with more than one study range from 57% to 99%.

This analysis points to the perceived usefulness and quality of the information resources provided by the CMLs as the strongest single impact of CML services as reported in these program evaluation studies. The combined evidence for this conclusion includes the rel-

Table 4
Characteristics of single CML program evaluative studies

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Algermissen (1)	17 months (9/72–1/74), usage statistics and informal comments Kansas City General Hospital, Kansas City, MO General Medicine Service	3 CMLs (full time) Ward rounds Daily	ca. 216 people (three 72-member teams) ''Docents'' (physician educators), residents, interns, nurses, pharmacists, medical students	■ Problems investigated: –Can CMLs meet the biomedical communication needs of students, house officers, physicians, & health care team members in a representative general hospital? ■ Hypothesis statements: –The CML can identify user information needs with 90% + accuracy –A high degree of correlation exists between the judgment of the CML and the user about the pertinence of the documents retrieved –A limited number of journals produce most of the pertinent documents	■ Monthly literature searches for teams nearly doubled ■ Number of CMLs increased from 2 to 3 ■ ''Highly positive response'' to program (search statistics and verbal testimonies) ■ Formal evaluation results not available for article
Roach (2)	1 year (7/73–6/74), usage statistics, weekly surveys and informal comments Cook County Hospital, Chicago, IL Pulmonary Medicine Team	1 CML Rounds and conferences Weekly	? ca. 25 people Physicians, administrators, nurse practitioners, nurse epidemiologists, general nurses, social workers, medical corpsmen, clerks	■ Problem investigated: –Have the patient care and educational information needs of a reorganized health care team been met? ■ No hypothesis statement	■ Enhanced awareness of the potential of library research ■ Enhanced awareness of the necessity for current awareness ■ Majority of surveyed found program beneficial ■ All surveyed kept CML bibliographies for future reference ■ Services saved users' time ■ CML can search literature faster and more efficiently ■ Patient care enhanced by quick & easy access to literature ■ Graduate education of residents enhanced
Lamb (3)	6 months (9/74–3/75), usage statistics, critical incident diaries, interviews, informal comments Hartford Hospital, Hartford, CT Department of Pediatrics, Department of Surgery, Department of Medicine	3 CMLs Teaching rounds Daily	? ca. 60 people Residents, medical students, clinical faculty, attending physicians	■ Problems investigated: –Can the medical librarian with special skills and training serve as a valuable interface between the health professional and the knowledge explosion in medicine to improve health care? –What contribution can the CML make to clinical teaching? –Can the CML change the information seeking behavior of health professionals? ■ Hypothesis statement: –The CML can be an effective interface between the health professional and the knowledge explosion by providing information quickly and organizing a core of clinical readings	■ The CML can be accepted as a working member of the patient care teaching team ■ The CML answers questions quickly & the information provided influences the management of patient problems ■ Information seeking by health professionals is often ineffective ■ CMLs, by example and instruction, can strengthen health professionals' information seeking skills ■ Since patient care questions recur, a patient care information system is both feasible and necessary
Staudt (4)	6 months (1/75–6/75), usage statistics & questionnaires, in-depth interviews (6/75) Washington University, St Louis, MO Department of Medicine	1 CML Residents' report meetings ? Weekly	39 residents 16 people interviewed Questionnaires with each search (324 responses)	■ Problems investigated: –What is the ''real worth'' of the CML program? –What cost-benefit ratios would support enlarging, maintaining or dropping the program? –How much was the service used & how much did it cost? –For what purposes was the service used? –If the service was discontinued, would there be any carry-over in library use?	■ 334 searches done for 39 residents (33 to 80 per month) ■ Costs averaged $661/month or $17/month/resident ■ Survey results: –Services used for general knowledge (42%), patient diagnosis or treatment (35%) –76% of searches shared with average of 7 other people –Slightly more use of library by residents provided CML services –Residents unwilling to pay for services –85% said CML search results were ''adequate'' ■ ''On-target'' relevant articles retrieved averaged 25% of total

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
				–Could the service be provided from the library? –Would users be willing to pay? –What was quality of the service for patient care & education? ■ No hypothesis statement	
Schnall (5)	20 months (9/73–5/75), usage statistics, questionnaire (5/74), CML work statistics University of Washington, Seattle, WA Neonatal Intensive Care Unit Department of Orthopedics	2 CMLs Rounds (NICU) 3 times per week Morning work rounds (Ortho) 2 times per week	36 people in NICU 26 people in Orthopedics Interns, residents, medical students, nurses, physical therapists, physicians	■ Problems investigated: –How much benefit was provided to individual patients & to the education of the health care team? –Did service provide value for patient diagnosis or treatment? –Did the service save users' time? –Did the service increase awareness of library services? –How well did CMLs perform? ■ No hypothesis statement	■ Users wanted service to continue (100% NICU, 93% orthopedics) ■ 100% saw value for education or continuing education ■ Saw value for patient diagnosis & treatment (97% NICU, 67% orthopedics) ■ Saved time (100% NICU, 93% orthopedics) ■ Would have still searched without CML (60% NICU, 53% orthopedics) ■ Awareness of library resources increased (97% NICU, 87% orthopedics)
Greenberg (6)	ca. 2 years (75–77), with final questionnaire (1977) Yale–New Haven Hospital, New Haven, CT Department of Pediatrics Department of Psychiatry Department of Internal Medicine Surgical Subspecialties: Neurosurgery Orthopedic Surgery Urology	4 CMLs Patient-management conferences 3 hours per week	98 people "Clinicians"	■ Problems investigated: –Did the service enhance the quality of patient care? –Did the service increase awareness of new clinical research? –Did the service influence clinicians' information seeking behavior? –Did the service establish CML's role as member of the patient care team? –Was the CML program accepted by clinicians? ■ No hypothesis statement	■ Survey responses on scale: 1 = low/disagree to 4 = high/agree –Service supported education (2.85), patient care (2.73), research (2.47) –Service affected or altered patient care (2.64) –Service provided relevant information (3.45) –Service provided accurate information (3.48) –Service improved awareness of current developments & research (2.74) –Service saved time (3.75) –Service changed information seeking patterns (3.04) –CML information was shared with others (3.29) –CML has been well integrated into unit (3.32) –Communication barriers with CML? (95% no) –CML has adequate subject knowledge? (97% yes) –CML restricts or alters normal clinical proceedings? (96% no)
Marshall/Hamilton (7)	ca. 2 years (75–77), regular interviews, return visits to patients McMaster University Medical Centre, Hamilton, ON Gastroenterology Programme	1 CML Morning conference rounds 1 time per week Bedside rounds 1 time per week	50 people Health professionals including nonphysician members of team ? ca. 360 people Patients	■ Problems investigated: –Did the service assist patients to participate knowledgeably in their own health care? –Did the service assist health care team to apply latest information to patient care? ■ No hypothesis statement	■ Service kept users more up-to-date with clinical literature ■ Services encouraged more independent use of library ■ Patients & families appreciated access to information ■ CML gained skills in interviewing & needs assessment
Gunning (9)	2 years (76–78), use statistics, pre- and post questionnaires Los Angeles County Harbor–UCLA Medical Center, Los Angeles, CA Obstetrics/Gynecology Department	1 CML Patient care review conferences Weekly	12 people Residents, faculty staff physicians	■ Problems investigated: –Did the service increase learning & improve quality of patient care? –Did the service retrieve information for users in more efficient & timely manner? Was it feasible for CML to be a member of patient care team? ■ No hypothesis statement	■ Library consultation services increased from 25 to 100% ■ Awareness of MEDLINE services increased from 75 to 100% ■ Database searches increased 120% ■ Program cost ca. $3,000/year for time (4.5 hours/week) & searches ■ Effect on quality of patient care "is difficult to assess"

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Scura (10)	5 months (9/79–1/80), follow-up questions when articles distributed John Dempsey Hospital (University of Connecticut), Farmington, CT Medical Service Pediatric Service	1 CML Bedside rounds House staff conferences 2 days per week	50 people interviewed (random sample from 287 searches) House officers (residents)	■ Problems investigated: –Did the service benefit patient care? –Did the articles provided affect patient management? ■ No hypothesis statement	■ 92% of residents read CML-provided articles ■ 82% said articles were source of new information ■ 20% said articles affected patient management
Marshall/Neufeld (11)	1 year (9/78–8/79), usage statistics, post-intervention interviews, evaluation forms McMaster University Medical Centre, Hamilton, ON Intervention units: Rheumatology, Obstetrics, Neurology, Pediatrics Control units: Hematology, Diabetic day care, Pain clinic, Community psychiatry	2 CMLs (half time) Morning conference rounds Bedside rounds ? Daily	114 health professionals interviewed (76 study teams, 38 control teams) Physicians, allied health professionals, nurses 140 patient and family member requests (52 evaluation forms returned)	■ Problem investigated: –How effective were the educational services provided by CMLs to health professionals and to patients? ■ No hypothesis statement	■ Service answered ca. 600 questions & provided 1,200 documents (40% for physician, 24% for patients, 21% for allied health, 15% for nurses) ■ 444 information searches for health professional (331 from direct requests, 113 from questions "perceived" by CML) ■ Study group more likely (84%) to use library services than control group (71%) & more likely to value these services (60% to 38%) ■ 67% of study group said CMLs changed their pattern of information seeking ■ Study group found health professions services more useful (98%), than patient information services (66%)
Grose (12)	6 months (8/80–1/81), usage statistics, questionnaire St. Lukes Episcopal Hospital, Houston, TX Baylor Family Practice Center	1 CML Morning reports ? Daily	ca. 20 people Residents	■ Problem investigated: –Did the service provide cost-effective continuing education support for residents? ■ No hypothesis statement	■ CML attended 52 conferences & received 89 information requests ■ Services cost ca. $10/hour for CML time, plus $2.11 for article copies ■ 80% rated information to be of high educational value ■ 100% rated time-savings highly ■ None said CML had impact on freedom of discussion ■ 50% felt CML prompted more questions from health care team ■ Direct impact on patient care was "difficult to evaluate"
Harmony (14)	6 months (9/80–2/81), usage logs, questionnaire (2/81) University of Cincinnati Teaching Hospitals, Cincinnati, OH Internal Medicine	2 CMLs Morning report conferences ? Daily	53 people (35 responses) Faculty physicians, residents, 3rd & 4th year medical students	■ Problems investigated: –How did users rate the quality of services provided? –Was information retrieved by CMLs relevant and of good quality? –Was information provided in a timely manner? –Was CML-provided information readily accessible to all who need it? –How much time and money are needed to provide good services? ■ No hypothesis statement	■ 143 requests for information received (44% residents, physicians 31%,16% medical students, 9% CML-initiated) ■ 3.5 hours of staff time per request; total cost ca. $75 including searching & copying ■ 100% supported continuing the CML services ■ 100% said service was valuable for patient care and education ■ 94% said quality of information was good or excellent ■ 97% said CML ability to locate relevant information was good or excellent ■ 28% said would usually do own search without CML service
Tobia (15)	3 months (5/82–7/82), usage statistics, evaluation forms with search results University of Texas Health Sciences Center at San Antonio, TX Department of Medicine	1 CML "Clinical Information Consultation Forms" 24-hour access from Medicine Reading Room Morning Report 1 time per week	26 people (37 evaluations returned) Residents	■ Problem investigated: –Could a clinical information consultation service obviate the need for a CML to attend morning report rounds? ■ Hypothesis statement: –The same results will be achieved using a consultation form as with having a CML attend rounds	■ 126 consultation requests received ■ Librarian time was 0.9 hours per request ■ 46% used for patient care, 48% for general information ■ 100% said adequate response time and saved time (average of 2.2 hours) ■ 100% said service should be continued ■ 92% said librarian accurately pinpointed the subject ■ 94% said they shared information with ward team

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Glick (16)	6 months (9/82–2/83), usage statistics, survey with search results (3/83) Froedtert Memorial Lutheran Hospital, Milwaukee, WI Department of Neurology Department of Medicine Department of Nursing	1 CML Grand rounds Department conferences Nursing grand rounds ? Weekly	?100+ people Medical staff, residents, medical students, nurses	■ Problems investigated: –Could a CML program help increase use of a new hospital library? ■ No hypothesis statement	■ CML program saw increase in reference requests (+21%) and search requests (+178%) ■ Survey results: –''Almost total satisfaction with [CML program] results'' –''Great enthusiasm for the library''
Yates-Imah (18)	34 months (8/81–5/84), usage statistics, informal user feedback San Francisco General Hospital, San Francisco, CA Family Practice Inpatient Service	1 CML Attending rounds 1 time per week	? ca. 15 people Residents, 4th year medical students, clinical pharmacy students, attending physicians, behavioral scientist, gastroenterologist	■ Problems investigated: –Did the service provide relevant information resources for patient care problems? –Did the service alert users to library resources? –Did the service help attending MDs build a useful reading file? ■ No hypothesis statement	■ CML participated in 113 rounds sessions, resulted in 197 searches ■ 460 articles photocopied ■ Feedback from patient care team: –CML was ''well accepted'' as part of team –Information provided was important in patient diagnosis & management –CML was ''important link'' in library awareness & use –Valuable team time was saved
Eaton (19)	3.5 years (11/78–6/82), usage statistics, pre-questionnaires and 1-year post-interviews or questionnaires for implementation with each team University of Texas Medical Branch at Galveston, TX Clinical Teams Surgery/Urology Pediatrics (nephrology, perinatology, immunology/allergy) Internal Medicine/Endocrinology Family Medicine	3 CMLs (full time) Patient rounds 1 time per week Conferences and grand rounds As scheduled	12 people (urology) Residents, faculty physicians 10 people (pediatrics) Research associate, clinical nurse specialist, fellows, faculty physicians 27 people (family medicine) Residents, faculty, physicians 8 people (internal medicine) Faculty physicians	■ Problems investigated: –Can a model with consistent standards be established for the evaluation of CML programs? –Can a CML service change health care team perceptions of librarians? –Can CMLs influence team information-gathering habits? –Can CMLs improve the quality & availability of information for the team? –Can CMLs increase use of the library to answer clinical questions? –Can CMLs increase team knowledge of the current clinical literature? –Can CMLs lower the costs of providing information services to clinicians? –Can CMLs help to improve the process of patient care? ■ Hypothesis statements: –CML services will strengthen positive perceptions of librarians –CML services will improve health care team information–gathering habits –CML services will improve the quality & availability of team information –CML services will increase use of the library for clinical questions –CML services will increase team knowledge of the current literature –CML services will lower the costs of clinical information services –CML services will help to improve the process of patient care	■ Opinions were more positive (on 5-point Likert scale) after exposure to services for: –Librarians attending department seminars (4.45 to 4.70) –Librarians serving as members of health care team (4.05 to 4.33) –Librarians selecting appropriate titles (4.61 to 4.68) –Librarians accompanying teams on rounds (3.17 to 3.78) ■ Opinions were less positive after exposure to services for: –Librarians attending daily staff meetings (3.51 to 3.45) –Librarians generating bibliographies (4.65 to 4.63) ■ More users felt obtaining materials from the library was easy after exposure to CML services (45% pre and 55% post)

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Miller (20)	5 years (78–83), daily logs, survey (1981) Hospital of the Medical College of Pennsylvania, Philadelphia, PA Department of Medicine	1 CML (full time) Morning report Attending rounds Several times per week	ca. 175 people Residents (55), faculty physicians (40), volunteer faculty (60), medical students (20)	■ Problems investigated: –What portion of CML services supported patient care, research and teaching? –How well were CMLs accepted by the health care team? –Did the use of CML services significantly increase over time? ■ No hypothesis statement	■ Significant trends over 5 years of CML service: –Increase in queries by faculty (92 to 319/year, r = 0.93) and by house staff (219 to 523/year, r = 0.94) –Decrease in CML-anticipated, unsolicited information (97 to 12/year, r = −0.88) –More use of CML for patient-related queries (203 to 483/year, r = 0.96) –Fewer requests obtained on rounds (260 to 98/year, r = −0.99) –More requests received in library or by phone (126 to 675/year, r = 0.97) ■ 1981 survey of CML use purposes: –Patient care (77%), teaching (72%), research (61%)
Barbour (21)	2.5 years (83–85), usage statistics, surveys of departing residents Veterans Administration Medical Center, Hampton, VA Department of Medicine Service	1 CML Morning report Daily	? ca. 20 people Chief of medical service, residents, interns	■ Problems investigated: –Did CML services increase use of medical literature by residents? –Did the services provide an effective & rapid information delivery system? –Did the services provide clinical value in diagnosis or treatment? –Did the services result in increased use of the library by residents? ■ No hypothesis statement	■ Database searches for house staff increased (18.5% of 358 in 1982 to 43% of 992 in 1985) ■ 100% said used CML-provided literature ■ 95% said literature was of clinical value ■ 86% said service saved time ■ 91% said service provided sources they would not have found ■ 95% said their use of library increased as result of service
Veenstra (23)	1 year (7/88–6/89), questionnaire (6/89) Hartford Hospital, Hartford, CT Department of Surgery Department of Pediatrics Department of Medicine	1 CML ? Venue & frequency not specified	33 people (30 usable responses) Senior residents, junior residents, transitionals and interns	■ Problems investigated: –Has end-user searching lessened the need for clinical information specialists? –Do CML services still have an impact on patient care? –Do CML services provide useful additional information after end-user searches? –Do users share CML-provided information with others? ■ No hypothesis statement	■ Senior residents sought services most often, junior residents least often ■ 97% said CML-provided information had impact on patient care ■ How frequently services had patient care impact? (40% to 59% of time) ■ 70% said would do own search before consulting CML ■ 93% said CML provided them with ''new'' information ■ How often is CML-provided information shared with others? (56% of time for junior residents to 96% for first year interns) ■ 77% said would use CML more frequently in future
Veenstra/Gluck (24)	3 months (9/90–11/90), CML activities log, questionnaires with search results Hartford Hospital, Hartford, CT Medical Intensive Care Unit Coronary ICU	1 CML (full time) Bedside rounds Morning report Conferences ? Several times per week	43 people House officers (31 in MICU, 12 in CCU)	■ Problems investigated: –How effective is an ongoing CML program in an intensive care unit? –Did the services aid in patient diagnosis? –Did the services contribute to a better understanding of therapy? –Did the services result in improved patient management? –What were the average costs of these CML services? ■ No hypothesis statement	■ 66 requests received for patient care information, 43 questionnaires returned ■ 63% said attempted to answer question before consulting the CML ■ 63% said CML provided new information ■ 37% said information aided in diagnosis ■ 51% said information contributed to therapy ■ 30% said information improved patient management ■ The average total cost of answering each question was $45.21 ■ The CML spent an average of 47 minutes on each question
Kuller (25)	4 months (12/90–3/91), physician ratings of selected articles Presbyterian University Hospital, Pittsburgh, PA Department of Medicine	1 CML Morning report Daily	24 people Faculty physicians, residents	■ Problem investigated: –Can CMLs effectively substitute for physicians as selectors of useful medical literature? ■ No hypothesis statement	■ Of 76 CML searches with 2,316 citations, a total of 452 were selected independently by the requesting resident and CML as relevant to the search topic ■ The residents then reviewed and returned evaluations of 278 full-text articles ■ CML selections were comparable to those of residents in overall utility as rated by the residents

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Royal (26)	11 months (12/90–10/91), usage statistics, survey (5/91), random questionnaires with search results, final survey (10/91) University of Alabama at Birmingham Veterans Administration Medical Center, Birmingham, AL Combined Autopsy Services	1 CML Gross Pathology Conference Once a week Pathology review conference Once a week	31 people Faculty physicians, residents	■ Problems investigated: –Did CML services provide value for students, residents, & faculty in an autopsy service? –Did the services increase use of the medical literature? ■ Hypothesis statement –CML services will significantly improve access to the most recent patient disease & treatment information	■ 90% said service was very useful to residency program ■ 97% said service was very useful to me personally ■ 61% said information provided greatly updated my knowledge of the disease process ■ 45% said information provided changed my interpretation of the pathology in some cases ■ 80% said information aided my literature review greatly ■ 100% said CML program should be continued
Pasquinelli (27)	6 weeks (ca. 93–94), final survey Eastern Virginia Medical School, Norfolk, VA Department of Pediatrics	1 CML In-patient rounds 3 times per week	17 people Residents (12) Attending physicians (5)	■ Problems investigated: –What was the clinical care & education impact of a CML on in-patient rounds? –Did the CML provide acceptable information turnaround time? –How useful was the CML-provided information? –Was the volume of CML-provided information appropriate? ■ No hypothesis statement	■ Information turnaround time from CML was judged to be good ■ The usefulness of the information provided was good ■ The type & volume of information provided was appropriate ■ The information chosen by the CML met the need to provide patient care ■ Having the CML on rounds had a positive effect on patient care ■ The project was judged to be worth continuing
Giuse (28)	6 months (7/97–12/97), follow-up questions when articles distributed, blinded survey after each monthly rotation Vanderbilt University Medical Center, Nashville, TN Medical Intensive Care Unit Neonatal Intensive Care Unit Hematology/Oncology Myelosuppression Unit Clinical Research Center	4 CMLs (full time) Bedside rounds Daily	38 people Physicians, nurses, pharmacists	■ Problems investigated: –Can CMLs display a significant understanding of the clinical environment & individual clinical cases? –Can CMLs become legitimate partners in the provision of high-quality health care? –Did clinicians trust the CML's ability to evaluate, interpret, & synthesize the medical literature? –Did the CMLs provide useful information that improved patient care? ■ No hypothesis statement	■ Assessments of CML program (1 = low, 10 = high): –Overall usefulness (9.5) –Avoided some referrals (7.7) –Knowledge gained (9.2) –Improved patient care (8.8) –Effectiveness of CML's presentation of literature reviews (9.4) –Usefulness of full-text articles (9.4) –Accuracy of CML's interpretation of the literature (9.5) –Relevance of the information provided (9.5) –Appropriateness of CML's inquiries during rounds (9.4)
Iruoje (29)	4 months (6/98–9/98) usage statistics, question when articles distributed University of Lagos, College of Medicine, Lagos, Nigeria Department of Pediatrics	1 CML Clinical ward rounds Weekly	? ca. 10 people "Clinicians," resident doctors	■ Problems investigated: –How can academic clinicians overcome the lack of time to do a thorough search of the medical literature? –Would CML services improve patients' care? –How many clinical questions did the CML provide answers to, or fail to answer? –How promptly did the CML provide answers to clinical questions? –How useful were the answers to clinical questions provided by the CML? ■ Hypothesis statement: –The CML can play a useful and significant role in ameliorating the problems associated with the information needed by the clinician for patient care	Analysis of answers provided by CML & residents for 6 questions: –CML responses provided in 1 to 13 days (50% in 1 day) –Resident responded to 50% of questions (in 1 to 10 days) –67% of CML-provided materials judged "very useful" –50% of resident-provided materials judged "useful"

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Dodson (30)	3.75 years (7/92–4/96), usage statistics, monthly questionnaires (11/93–4/94) University of Washington Medical Center, Seattle, WA Internal Medicine Service	1 CML Resident report 4 times per week	31 people Residents	■ Problems investigated: –How can library increase support for academic medicine clinical programs? –Can a CML program provide a better link from the library to patient care at the bedside? –Was CML-provided information useful or relevant for clinical decisions? –Did CML-provided information change diagnosis, treatment, or advice given to patients? –Did CML-provided information help avoid additional tests, surgery, infections, or death? ■ No hypothesis statement	■ Information supplied was useful or relevant (100%) ■ Information supplied provided new knowledge (100%) ■ Information supplied substantiated what already knew (77%) ■ Information supplied contributed to better clinical decisions (100%) ■ Information supplied changed: diagnosis (40%), choice of tests (65%), choice of drugs (71%), choice of treatment (68%), length of hospital stay (34%), post-hospital care or treatment (60%), advice given to patient (90%) ■ Information supplied contributed to avoiding: additional tests (63%), patient mortality (31%), surgery (15%), hospital infections (6%)
Morley (31)	1 year (99–00), informal user feedback University of New Mexico Health Sciences Center, Albuquerque, NM Internal Medicine Department Child & Adolescent Mental Health Team 1 year (1/00–1/01), regular questionnaires, control teams to compare information use Barnet Community Health Care, NHS Trust, London, UK Multidisciplinary teams Anaesthesia & critical care Integrated medicine Musculoskeletal Renal Clinical Practice Women & Perinatal Emergency Medical & Stroke Pain Management Cardio-Respiratory Surgery	1 CML (full time) Clinical rounds 2 hours/day 2 CMLs Varied by team: Team meetings In clinics Ward rounds	ca. 270 people (240 internal medicine, 30 mental health) Clinical faculty, housestaff, clinical pharmacist, pharmacy student, physician assistant students, nursing staff ? 150+ people Clinicians	■ Problems investigated: –Can a CML program improve library services for the clinical components of the medical center? –Did the services provide quick, easy access to relevant clinical information? –Did the services help to compensate for clinicians lack of searching skills? ■ No hypothesis statement ■ Problems investigated: –Did the CML service support clinicians in making evidence-based decisions about patient care? ■ No hypothesis statement	■ Quick, easy access to information ■ Saving time for the busy practitioner ■ CML as resource for knowledge to compensate for lack of in-depth searching skills ■ Administrative support for expanding program to more teams Reid (32) ■ ''Clinicians are very satisfied with the service they receive'' ■ Overwhelming case loads mean they have trouble finding time to read, appraise and apply CML-provided information ■ CML work has highlighted lack of good quality evidence in field of mental health
Glassington (33)	14 months (8/00–3/01), ''action research framework'' University College London Hospitals, London, UK Neonatal Unit Teenage Cancer Trust Unit Tuberculosis Department (Community Trust)	1 CML Weekly meetings	? ca. 100 people A core team in each unit/ department multidisciplinary	■ Problems investigated: –Has the CML service been effective in supporting the setting & monitoring of standards in delivering clinical care (clinical governance)? –Have the CMLs become integral parts of the multidisciplinary health care teams? ■ No hypothesis statement	■ Action research framework: regular meetings to strengthen areas of weakness ■ Overcoming communication barriers to allow CML to become an integral part of the multidisciplinary team ■ Need for constant drive from the CML and ongoing presence within clinical department

Table 4
Continued

Author (study no.)	Evaluation period, strategy and setting(s)	No. of CMLs, venues, and frequency of services	Population/ sample studied	Problems and hypotheses investigated	Results
Ward (34)	6 months (ca. 2000), usage statistics, questionnaires with search results, questionnaire to all team members, team leader interviews Leicester General Hospital, Leicester, UK Nephrology Stroke Unit Neonatal Intensive Care Obstetrics & Gynaecology	2 CMLs Ward rounds Audit meetings Case conferences Nursing & Professionals Allied to Medicine (PAM) meetings "As many as possible"	? ca. 120 people (14 responses to "individual search" questionnaire & 15 responses to general evaluation) Lead clinicians, nurses, PAM	■ Problems investigated: –Can a CML service in an acute hospital setting provide quality filtered research evidence at the point of clinical need? –Did the service overcome the barriers of lack of clinician time, lack of search expertise, and lack of access to networked computing resources? ■ No hypothesis statement	■ 23 searches per month carried out by the CMLs ■ 73% said information had impact on patient care ■ 64% said information had impact on teaching ■ 60% said information had impact on case presentations ■ 46% said information had impact on research ■ 30% said information had impact on management ■ 27% said information had impact on publication

Table 5
Reported results of single-program CML service evaluations

Results category	No. of studies (& individual results) reported	Estimated total no. of users (& uses) studied	No. of studies (& results) reported as "positive" percentages (1)	Total users (& uses) studied for "positive" percentage results	Range of "positive" individual percentage results reported	Weighted average (2) of the "positive" percentage results
Patient care impact	20 (41)	837 (361)	12 (29)	556 (361)	6% to 100%	65.4%
Usefulness, adequacy or quality of information provided	19 (29)	1,209 (324)	12 (20)	563 (324)	61% to 100%	89.3%
Use statistics and trends	12 (16)	693 (324)	n/a	n/a	n/a	n/a
Traditional library services impact	11 (14)	646	3 (6)	253	55% to 97%	77.4%
Overall CML program value	11 (12)	970 (37)	4 (5)	165	93% to 100%	99.0%
Educational impact	10 (10)	566 (324)	6 (6)	345 (324)	42% to 100%	68.6%
Information seeking and sharing impact	9 (10)	507 (361)	6 (7)	235 (361)	28% to 94%	71.7%
Health care team acceptance of CML	7 (14)	388	1 (1)	20	50%	50.0%
CML services saved users' time	7 (9)	516 (37)	3 (3)	82	86% to 100%	94.7%
Relevance or accuracy of information provided	6 (8)	267 (361)	3 (3)	100 (361)	25% to 97%	56.7%
Program costs	6 (7)	214 (37)	n/a	n/a	n/a	n/a
Speed & efficiency of service	6 (6)	432	1 (1)	10	50%	50.0%
Research impact	4 (6)	344	2 (3)	189	27% to 61%	59.1%
Patient impacts	2 (2)	474	1 (1)	114	75%	75.0%
Negative impacts	2 (2)	250	n/a	n/a	n/a	n/a
"Management" impact	1 (1)	14	1 (1)	14	30%	30.0%

(1) The remaining results were reported in other ways (such as Likert scale averages), or as simple statements without supporting numeric data.
(2) Weighted average = $\Sigma xy/\Sigma y$, where x = the percent of all users (or uses) studied for each "positive-perception-of-CML-services" result reported, and where y = the number of users (or uses) for each study result who reported (or that indicated) positive perceptions of CML services.

atively large cumulative number of studies (19) and results (29) reported, individual users (1,209) and uses (324) studied, and the weighted average positive results (89%) for the twelve studies with quantitative percentage results statements. The cumulative evidence supporting the conclusion that CML services have contributed to improved patient care by their health professional users is also relatively strong. This evidence includes 20 studies, 41 results statements, and a relatively large number of individual users (837) and uses (361) studied. However, the twelve studies reporting positive opinion percentages about the value of CML services for patient care have a significantly lower weighted average of about 65%.

While the cumulative evidence for other potential impacts of CML services from these studies is also generally positive, it is not strong since the numbers of studies, results reported, and users (and uses) studied are quite small for those categories compared with the usefulness and patient-care impact-study results. Potentially negative impacts of CML services were only reported in two of these thirty studies. Reid, studying about 150 clinician users in ten multidisciplinary health care teams, reported the problem of overwhelming case loads faced by clinicians who find little time to read, appraise, and apply the CML-provided information; Glassington, studying about 100 users in three multidisciplinary health care units, reported the problem of overcoming communication barriers to allow CMLs to become a more integral part of the multidisciplinary health care team.

DISCUSSION

Our goal in conducting this systematic review of the literature evaluating CML programs was to determine if the cumulative evidence would provide additional support for the hypothesis that CML services contribute to improved patient care or better performance by health care professionals or students. As expected, these results show very little support for this hypothesis, with only thirty-five studies published in the past thirty years using any kind of formal evaluation methods. In addition, the published evidence consists almost entirely of descriptive surveys of user opinions and inconsistent statistics measuring the quantity of CML services provided, usually for periods ranging from six to twelve months.

Comparative quantitative research methods or carefully and systematically structured qualitative research methods have been used very rarely, with only four studies using historically controlled before-and-after methods or comparison control groups. Thus, the closest approximation to a meta-analysis statistical summary of the cumulative evidence from these studies that could be derived was the weighted averages calculated from some study survey results stated as percentages (presented in Table 5). This cumulative evidence does help to support somewhat the perception that a large majority of CML program users do find the information resources provided useful and of good quality. A clear majority of these users also state that CML services have contributed in some way to improved patient care. However, no study to date has attempted to measure the direct or indirect impact of CML services on the *outcomes* of patient care (such as hospital length of stay, patient mortality, adverse drug effects, etc.), as the Klein study [92] did with hospital library services. No study provides more than unverified opinions of health care professionals and students about those potential impacts. Objective evidence for the positive impact of CML services at this level is still missing.

Another important problem mentioned frequently in the non-evaluative, descriptive literature on CML programs [93–96] is the need to justify the special professional training and other costs associated with providing a rather intense level of information services for small subsets of a total user population. These evaluative studies provide very little comparative data or other evidence to help justify the cost-effectiveness of CML services versus other methods of providing or promoting access to knowledge-based information in clinical, patient care settings. For example, they provide very little evidence to justify the cost-effectiveness of CML services in comparison to proposals for informationist services that would be provided by health professionals with doctorate degrees and much higher salary requirements. The two studies that do provide some cost-benefit evidence (Kidder and Demas) are not encouraging about the general level of understanding and willingness to support these services financially or politically. Carefully structured qualitative studies could be very revealing and helpful in understanding the factors that contribute to cost-effective CML service programs, but these are also almost entirely missing from the literature. The Lamb study gathered this kind of useful information in the form of CML diaries, but then failed to subject that data to a systematic or rigorous analysis.

Formal studies looking at more than one CML program have also been very rare, including only the Kidder survey of new medical school libraries and the Cimpl literature review in 1985. Finally, very few of these 35 evaluative studies even discussed actual or potential problems with CML services (Kidder, Cimpl, Demas, Reid, and Glassington). The Demas study came closest to providing a forthright analysis of negative data about the potential support for CML service programs in academic health sciences centers, but this was based only on surveyed opinions using short CML scenario statements.

CONCLUSION AND RECOMMENDATIONS

With so little cumulative evidence about the impact of CML services on the provision of health care and on the training of health professionals in clinical settings, what can be concluded about the potential future of such programs or the need for additional studies to guide the further development of these services? As is the case with most research, this systematic review of

the evaluative studies of CML services conducted over the past thirty years raises many more questions than it answers. Clearly, there is some relatively strong evidence that these programs have been well accepted and liked by most of the targeted clinicians and students served. However, the total amount of such evidence is not great, most of it is descriptive rather than comparative or analytically qualitative, and it does not rise to the level of the ''best evidence'' called for to support evidence-based medicine or librarianship.

This review also suggests many additional questions that merit further study:

- In what settings can CMLs work most effectively? Where are CML-health professional interactions most helpful, productive, and conducive to better patient outcomes (rounds, conferences, or others)?
- The changing health care landscape, with more care being provided in outpatient settings, could dramatically change the need for, or the types of services needed from, CMLs. For example, none of the programs described or evaluated in the literature to date have been targeted at health professionals working in outpatient clinics.
- What kind of work schedule for CMLs is most effective?
- What is the optimal ratio of CMLs to health professionals served?
- What training or skill sets are needed to make CMLs or informationists most effective? Some opinions and examples of interesting approaches are described in these studies (see, for example, Giuse), but almost no evidence is presented showing that one approach is more promising than another.
- What is the optimum length of time over which a CML program should be evaluated? More trend analyses (such as Miller and Barbour) and before-and-after studies (such as Gunning and Eaton) could help to answer this question.
- How effective are CMLs who anticipate information needs compared with those who just respond to direct questions from clinicians? What kind of clinical information need is most effectively anticipated?
- What evaluation data gathering and analysis strategies are needed to allow program developers to effectively compare their outcomes with other CML programs?

Without the evidence provided from carefully researched answers to at least some of these questions as well as convincing analyses of the cost-benefit ratio for these services, it will be very difficult to justify the further development and growth of such services. Although continuing innovation and experimental new programs are valuable for exploring potential service strategies, standards are needed to consistently evaluate CML or informationist programs in the future. These need to include consistent data-gathering and analysis methods, comparable cost-benefit data, and standards for measuring patient care impacts and program value. A carefully structured multi-program study using such standards and including three to five of the best current CML or informationist programs could help define the true value of these services.

Whether such services continue to be provided by information professionals we call clinical medical librarians, or by a new cadre of professionals who combine the training of librarians with training in one or more of the health professions and call themselves informationists, is not as important for the future of these services as the need to study and answer some of the fundamental questions about the value of these services for patient care in clinical settings. If the true value (that is the cost-effectiveness) of CML services, by whatever name, can be clearly demonstrated with objective data about their effects on patient care, then financial and political support for these programs within health care organizations will follow naturally. However, much more high-quality research is needed to demonstrate the value of these services in comparison to other methods for supporting evidence-based health care in clinical settings.

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